REMARKS

CLAIM AMENDMENTS

Claims 14–17 are amended to recite that the loadlock chamber is not coupled to the pass-through chambers. The amendment is supported by Figure 2, in which the loadlock and pass-through chambers are identified as SWLL (single wafer load lock) and DG (de-gas chamber), respectively (specification at page 4, last line – page 5, line 1). The specification explains that the de-gas chambers DG of Figure 2 also function as pass-through chambers (page 9, lines 4–5 and 17–18; page 10, lines 6–7 and 15–18). The purpose of the amendment is to clarify that the loadlock chamber SWLL is distinct from the "Buffer" and "Transfer" chambers housing the robots.

PATENTABILITY ARGUMENTS

Claim 7

The invention of independent claim 7 improves the efficiency of a semiconductor manufacturing process performed using a common type of manufacturing equipment in which a first process chamber is coupled to a first robot, a second process chamber is coupled to a second robot, and one or more pass-through chambers are coupled between the two robots.

Specifically, claim 7 recites the following sequential steps (some initial steps are omitted for brevity):

Step 1: Coupling a first pass-through chamber to both first and second robots so that both robots can transfer a substrate into and out of the pass-through chamber (claim 7, lines 10–13).

Step 2: The first robot transferring the substrate into the pass-through chamber (line 15).

Step 3: Heating the substrate within the pass-through chamber (line 16).

Step 4: The second robot removing the substrate from the pass-through chamber (line 17).

Prior art processes required an unproductive time period during which a substrate was transferred through the pass-through chamber before it could be processed within the second process chamber, and any heating step required transferring the substrate into and then out of a heating chamber separate from the pass-through chamber. The claimed method performs the heating step within the pass-through chamber (Step 3), thereby eliminating the time otherwise required to transfer the substrate into and out of a separate heating chamber.

Claim 7 was rejected under 35 USC 102(b) as anticipated by Maxwell (US 5,996,353). The

rejection is improper because Maxwell fails to disclose a pass-through chamber that performs a heating step.

On pages 3–4 of the office action, the Examiner identifies elements of Maxwell that allegedly correspond to steps of claim 7. The Examiner's first three paragraphs are correct, but the remainder of the Examiner's comparison is erroneous.

The Examiner erroneously characterizes chambers 221 and 208 in Maxwell's Figure 8 as fulfilling the requirement of claim 7, 4th paragraph (i.e., Step 1 above), for "coupling one or more pass-through chambers to both the first robot and the second robot so that both the first robot and the second robot can transfer a substrate into and out of each of the pass=through chambers" (last paragraph on page 3 of the office action). The Examiner's characterization is erroneous because the alleged correspondence between Maxwell and the claim elements is inconsistent. If Maxwell's robots 220 and 221 correspond to Applicant's first and second robots as stated by the Examiner, then Maxwell's loadlock chamber 208 cannot be a pass-through chamber as defined by claim 7 because the one of the two robots, robot 220, cannot transfer a substrate into and out of the loadlock chamber 208. Likewise, Maxwell's loadlock chamber 208 cannot be a pass-through chamber as defined by claim 7 because one of Maxwell's two robots, robot 220, cannot transfer a substrate into loadlock chamber 208 as required by claim 7, line 15.

As for Maxwell's "chamber 221", presumably this is a typo by the Examiner because the Examiner previously correctly identified 221 as the second robot. Assuming the Examiner intended to refer to Maxwell's second robot chamber 203, this also cannot be a pass-through chamber as defined by claim 7 because one of Maxwell's two robots, robot 220, cannot transfer a substrate into and out of the second robot chamber 203.

Maxwell's chambers 228 and 230 — not 221, 208 or 203 as postulated by the Examiner — are the only chambers shown in Maxwell's Figure 8 that fulfill the requirement of claim 7 for "coupling one or more pass-through chambers to both the first robot and the second robot so that both the first robot and the second robot can transfer a substrate into and out of each of the pass-through chambers" because chambers 228 and 230 are positioned between the first and second robot chambers 202 and 203 so that both robots can transfer substrates into and out of chambers 228 and 230. However, as will be discussed in the following paragraphs, Maxwell does not anticipate claim 7 because Maxwell's chambers 228 and 230 cannot perform the heating step required by claim 7 .

The Examiner contends that the heating step in claim 7, line 16 (Step 3 above), is disclosed in

Maxwell at column 9, lines 15–20. However, Maxwell merely discloses performing heating in the four process chambers 204, none of which are pass-through chambers. Process chambers 204 are attached to the first robot chamber 202 so that only the first robot 220 can transfer a substrate into or out of a process chamber 204. None of Maxwell's process chambers 204 can be Applicant's claimed pass-through chamber because one of the two robots, second robot 221, cannot transfer a substrate into or out of a process chamber 204 as required by claim 7, fourth paragraph.

Furthermore, claim 7, at lines 15 and 17, requires two different robots to transfer the substrate into the chamber before the heating step and to remove the substrate after the heating step. That would be impossible if the heating step were performed in Maxwell's process chamber 204 because only one robot, robot 220, can transfer substrates into and out of Maxwell's process chamber 204.

Maxwell lacks any disclosure that heating can be performed in chambers 228 and 230, which are the only chambers that are coupled to both the first and second robots. Therefore, Maxwell fails to disclose the key feature of the claimed invention, i.e., performing a heating step within a pass-through chamber through which a substrate is transferred from a first robot to a second robot. Accordingly, claim 7 is patentable over Maxwell.

Claims 8–10, 14–16, 18 and 19

Claims 8–10, 14–16, 18 and 19 were rejected under 35 USC 102(b) as anticipated by Maxwell. Claims 8–10, 14–16, 18 and 19 are patentable over Maxwell because they are dependent on claim 7, which is patentable for the reasons just discussed.

Claims 8 and 9 further distinguish Maxwell by requiring the substrate to be transferred from one chamber to another in the following specific sequence (Steps 6–9 are required only in claim 9):

Step 1: Coupling a first pass-through chamber to both first and second robots so that both robots can transfer a substrate into and out of the pass-through chamber (claim 7, lines 10–13).

Step 2: The first robot transferring the substrate into the pass-through chamber (claim 7, line 15).

Step 3: Heating the substrate within the pass-through chamber (claim 7, line 16).

Step 4: Second robot removing the substrate from the pass-through chamber (claim 7, line 17).

Step 5: Second robot transferring the substrate to the second process chamber (claim 8, line 2).

Step 6: Second robot removing the substrate from the second process chamber (claim 9, line 2).

Step 7: Second robot transferring substrate into one of the pass-through chambers (claim 9, line 3).

Step 8: First robot removing substrate from said one of the pass-through chambers (claim 9, line 4).

Step 9: First robot transferring the substrate to the first process chamber (claim 9, line 5).

The Examiner's attention is directed to claim 7, line 14, claim 8, line 1, and claim 9, line 1, which use the terms "sequential" and "subsequent" to specify that the steps must be performed in the recited order. The Examiner contends the claimed transfer sequences are disclosed in Maxwell, but Maxwell merely discloses the possibility of transferring substrates among the chambers without disclosing any specific sequence, much less the specific sequences required by claims 8 and 9. Therefore, claims 8 and 9 are patentable over Maxwell.

Claim 10 is dependent on claim 9 and further recites that the pass-through chamber in which the heating step is performed (claim 7, line 16) is the same as the pass-through chamber through which the substrate subsequently is transferred in the steps of claim 9, lines 3 and 4. Requiring the use of the same pass-through chamber for these different sequential steps is much more specific that merely reciting that some arbitrary pass-through chamber is the "first" pass-through chamber. Since Maxwell fails to disclose the recited sequential transfer steps, claim 10 is patentable over Maxwell.

Claims 18 and 19 further distinguish Maxwell by requiring the steps of heating the substrate within the pass-through chamber by resistive heating or infrared radiation, respectively. The portions of Maxwell cited by the Examiner as allegedly disclosing these steps actually disclose performing heating only in a process chamber 204. As explained above, none of the process chambers 204 is coupled between the first and second robots so as to fulfill the claim requirements for a pass-through chamber. Therefore, Maxwell's disclosure of heating within a process chamber 204 fails to disclose such heating within the claimed pass-through chamber as required by claims 18 and 19. Accordingly, claims 18 and 19 are patentable over Maxwell.

Claims 11 and 20

Claim 11 is dependent on claim 9 and is further limited to the following sequence of steps (some steps are omitted for brevity):

Step 1: Coupling a first pass-through chamber to both first and second robots so that both robots can transfer a substrate into and out of the pass-through chamber (claim 7, lines 10–13).

Step 2: First robot transferring substrate to the first pass-through chamber (claim 7, line 15).

Step 3: Heating substrate in the first pass-through chamber (claim 7, line 16).

Step 4: Second robot transferring substrate to second process chamber (claim 8, line 2).

Step 5: Depositing Ta or TaN on substrate in second process chamber (claim 11, lines 2–3).

Step 6: Second robot transferring substrate to a pass-through chamber (claim 9, line 3).

Step 7: First robot transferring substrate to first process chamber (claim 9, line 5).

Step 8: Depositing copper on substrate in first process chamber (claim 11, lines 5–6).

Claim 20 defines a copper deposition process including the same 8 steps as claim 11 (claim 20, lines 14–23).

Claims 11 and 20 were rejected under 35 USC 103 as unpatentable over Maxwell in view of Loan (6,136,725).

On page 7 and the first half of page 8 of the office action, the Examiner applies Maxwell to claim 20 just as she applied Maxwell to claim 7 on pages 3-4 of the office action. The first paragraph on page 7 is correct, but the remainder of the Examiner's comparison is erroneous for the same reasons presented above in the patentability argument for claim 7.

As demonstrated in the patentability arguments for claims 7–9 et al., Maxwell lacks any disclosure of performing a heating step within a pass-through chamber coupled between two robots, as required by Step 3 above. Loan also lacks such disclosure. The only device disclosed by Loan that is coupled between two robots is the wafer handoff mechanism 701 in Figures 16 and 17. Loan lacks any disclosure of whether handoff mechanism 701 includes either a chamber or a heater (col. 23, line 56 – col. 24, line 7). Loan's only disclosure of heating is in chamber 130 (Fig. 15; col. 22, line 54; col. 23, line 27), which is not a pass-through chamber. Therefore, claims 11 and 20 are patentable over Maxwell in view of Loan because neither Maxwell nor Loan discloses performing a heating step within a pass-through chamber.

Claims 11 and 20 further distinguish the prior art by reciting additional steps of a process for depositing Ta or TaN followed by copper. The claimed invention is useful in systems in which one or more copper deposition chambers are clustered around a first robot and one or more Ta or TaN deposition chambers are clustered around a second robot, so that the substrate must be transferred through an intermediate pass-through chamber between the tantalum and copper deposition steps. The invention speeds up the process by eliminating at least one step because the initial heating step is performed in a pass-through chamber.

In contrast, the Loan prior art is capable of performing heating only in chamber 130 which is not a pass-through chamber. Therefore, Loan's heating step must be an additional step separate from the step of transferring the substrate through wafer handoff mechanism 701.

The Examiner cites Loan as disclosing the deposition of tantalum and copper. However, Loan fails to disclose the steps of the claimed invention which require the copper and tantalum deposition chambers to be respectively coupled to distinct first and second robots, with a pass-through chamber interposed between the first and second robots. Therefore, claims 11 and 20 are patentable over Maxwell in view of Loan.

Claims 12, 13, 21 and 22

Claims 12 and 13 are dependent on claim 9 and are further limited to the following sequence of steps (some steps are omitted for brevity):

Step 1: First robot transferring substrate to the first pass-through chamber (claim 7, line 15).

Step 2: Heating substrate in the first pass-through chamber (claim 7, line 16).

Step 3: Second robot transferring substrate to second process chamber (claim 8, line 2).

Step 4: Removing native oxide from surface of substrate in second process chamber (claim 12, lines 2–3).

Step 5: Second robot transferring substrate to a pass-through chamber (claim 9, line 3).

Step 6: First robot transferring substrate to first process chamber (claim 9, line 5).

Step 7: Depositing copper on substrate in first process chamber (claim 12, lines 5–6).

Claims 21 and 22 define a copper deposition process including the same 7 steps as claim 12 (claim 21, lines 14–23).

Claims 12, 13, 21 and 22 were rejected under 35 USC 103 as unpatentable over Maxwell in view of Loan and Chopra (6,413,858).

In the last paragraph of page 10 and all but the last paragraph of page 11 of the office action, the Examiner applies Maxwell to claim 21 just as she applied Maxwell to claim 7 on pages 3-4 of the office action. The last paragraph on page 10 is correct, but the remainder of the Examiner's comparison is erroneous for the same reasons presented in the patentability argument for claim 7.

As demonstrated in the patentability arguments for claims 11 and 20, Maxwell and Loan lack any disclosure of performing a heating step within a pass-through chamber coupled between two robots, as required by Step 3 above. Chopra lacks any disclosure of either heating or a pass-through chamber. Therefore, claims 12, 13, 21 and 22 are patentable over Maxwell in view of Loan and Chopra.

Claims 12, 13, 21 and 22 further distinguish the prior art by reciting additional steps of a process for removing native oxide and then depositing copper. The claimed invention is useful in systems in which one or more copper deposition chambers are clustered around a first robot and one or more oxide cleaning chambers are clustered around a second robot, so that the substrate must be transferred through an intermediate pass-through chamber between the oxide removal and copper deposition steps. The invention speeds up the process by eliminating at least one step because the initial heating step is performed in a pass-through chamber.

As explained in the patentability arguments for claims 11 and 20, the Loan prior art is capable of performing heating only in chamber 130 which is not a pass-through chamber. Therefore, Loan's heating step must be an additional step separate from the step of transferring the substrate through wafer handoff mechanism 701.

The Examiner cites Loan as disclosing the deposition of tantalum and copper and cites Chopra as disclosing removing native oxide before depositing copper. However, Loan and Chopra fail to disclose the steps of the claimed invention which require the copper deposition and oxide removal chambers to be respectively coupled to distinct first and second robots, with a pass-through chamber interposed between the first and second robots. Therefore, claims 12, 13, 21 and 22 are patentable over Maxwell in view of Loan and Chopra.

Claim 17

Claim 17 is dependent on claim 8 and further recites subsequent steps as follows:

Step 1: Coupling at least a first pass-through chamber to both first and second robots so that both robots can transfer a substrate into and out of the first pass-through chamber (claim 7, lines 10–13). Coupling a loadlock chamber to the first robot but not the second robot (claim 17, lines 2–3).

Step 2: First robot transferring the substrate into the first pass-through chamber (claim 7, line 15).

Step 3: Heating the substrate within the pass-through chamber (claim 7, line 16).

Step 4: Second robot removing the substrate from the first pass-through chamber claim 7, line 17).

Step 5: Second robot transferring the substrate to the second process chamber (claim 8, line 2).

Step 6: Second robot transferring substrate into one of the pass-through chambers (claim 17, line 6).

Step 7: First robot removing substrate from said one of the pass-through chambers (claim 17, line 7).

Step 8: First robot transferring the substrate into a loadlock chamber (claim 17, line 7), wherein the

loadlock chamber is coupled to the first robot but not the second robot in accordance with Step 1.

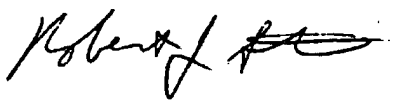
Claim 17 was rejected under 35 USC 103 as unpatentable over Maxwell in view of Loan and Chopra (6,413,858).

The Examiner cites Maxwell as disclosing a loadlock chamber 220 that is coupled to a first robot 202 but not to a second robot 203. However, the Examiner's characterization is erroneous because Maxwell's component 220 is a robot, not a loadlock chamber (column 9, line 10). The only loadlock chambers disclosed by Maxwell are the two loadlock chambers 208 (column 8, line 28). In addition, claim 17 is now amended to clarify that the loadlock chamber is not coupled to the one or more pass-through chambers. Hence, none of Maxwell's robots 220, 221 or robot chambers 202, 203 can be a loadlock chamber as defined in claim 17 because each of Maxwell's robots and robot chambers is coupled to Maxwell's pass-through chambers 228, 230.

The invention of claim 17 improves the efficiency of a semiconductor manufacturing process performed using the type of manufacturing equipment in which a loadlock and a first process chamber are coupled to a first robot, a second process chamber is coupled to a second robot, and one or more pass-through chambers are coupled between the two robots. Prior art processes required an unproductive time period during which a substrate was transferred through the pass-through chamber before it could be processed within the second process chamber, and any heating step required transferring the substrate into and then out of a heating chamber separate from the pass-through chamber. The claimed method performs the heating step within the pass-through chamber (Step 3), thereby eliminating the time otherwise required to transfer the substrate into and out of a separate heating chamber.

As demonstrated in the patentability arguments for claims 12, 13, 21 and 22, Maxwell and Loan lack any disclosure of performing a heating step within a pass-through chamber coupled between two robots, as required by Step 3 above. Chopra lacks any disclosure of either heating or a pass-through chamber. Therefore, claim 17 is patentable over Maxwell in view of Loan and Chopra.

Respectfully submitted,



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